Epidemicity of Poliomyelitis

Possible Role of Seasonal Variation in Food Quality

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• Seasonal variations occur in the phosphate, phospholipid and protein content of foods. The lower content occurs in the dry season. This is most often in the summer and fall months, which is the usual time of year for epidemics of poliomyelitis. Question is raised as to whether epidemics of poliomyelitis are a consequence of the host-virus balance being shifted in favor of the virus during this season because of the lower nourishing power of foods common to the daily diet.

As GROWING PLANTS do not absorb phosphate readily when soil moisture is depleted, the quality of food varies seasonally. Lowering of phosphate availability from the soil is associated with a decrease of protein and phospholipids as well as phosphate in plant and animal products derived from the soil. This seasonal phenomenon has attracted attention among agricultural workers because of its importance in animal health.[3, 4, 12, 23]

A seasonal variation which is significant in animal health should be worthy of study in regard to its possible effects on human health, even though multiple sources of food would make the effect of this seasonal change less precise in humans. Particularly, the suggestion is advanced that this seasonal fall of phosphate, phospholipids and protein in food should be studied as to whether it may be a factor in epidemics of poliomyelitis by lowering resistance to the disease. Despite all the research done on the question, the seasonal incidence of poliomyelitis has not been explained.[2, 14] Since the seasonal lowering of food quality corresponds in general with the late summer and fall prevalence of poliomyelitis, it is important to consider the possibility that there is some connection.

The present inquiry on the magnitude of seasonal change in food quality was prompted by observation of a localized epidemic of poliomyelitis in Humboldt County, California, in 1951 at the time of prolonged and severe drought. The possible significance of a rainfall deficiency in poliomyelitis epidemics is substantiated by descriptions of the excessively dry weather conditions which appear in the early reports of epidemics in Vermont and Massachusetts.[8, 16]

Hart, Guilbert and Goss[12] reported upon the decrease in phosphate and protein content of forage in California during the dry season (Chart 1).*

In general the climate of the north temperate zone is such as to bring about seasonal rise and fall in the protein and phosphate content of forage. Alterations in the seasonal trend occur from year to year as the climate varies. In Texas, the effect of rainfall is usually reflected in increased content of phosphate in forage in the month immediately following the heaviest precipitation.[3]

The phosphate content of the blood of drought-grazed animals gradually decreases. Depleted blood is associated with poor quality meat. Investigators at the Kansas Agricultural Experimental Station ob-

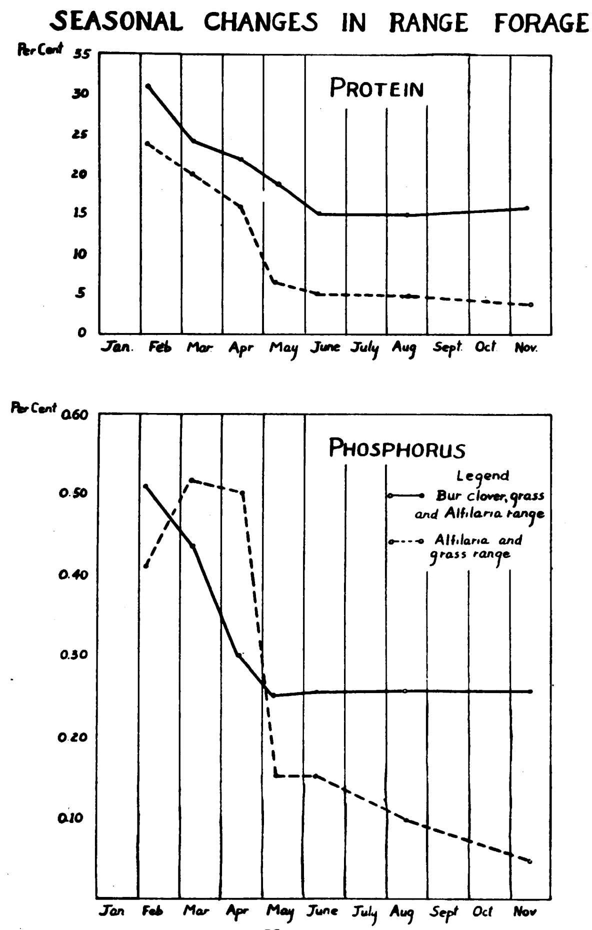

Chart 1.

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served that low-phosphate beef had three distinctive characteristics.[11] Because of changes in the phospholipids, it lacked flavor and had a tendency to spoil easily during storage. It also contained an abnormally large quantity of water. In sheep[18] tissue formation is delayed by a low-phosphate diet. Ingested protein is absorbed but, in the absence of phosphate, the amino acids are broken down and excreted by the kidney instead of being formed into body tissue. Thus, beef and mutton slaughtered in the dry summer and fall cannot be expected to nourish people to the extent that they do in the spring, when the forage provides more phosphate and protein.

Dairy products are even more important than meat as a principal food staple in the American diet. When milk is inspected, phosphate and protein are measured together in a composite known as solids-not-fat. It has been found that solids-not-fat are lower in the summer and fall.[10] More significantly, they have been generally declining over the past 50 years. In England, solids have declined from 9 per cent to less than 8 per cent of whole milk. In California, the permissible minimum for milk solids was lowered by law in 1947 from 8.5 per cent to 8.15 per cent.[7]

Good farm practices can reverse this serious drop in milk solids. Decayed vegetation worked into the soil absorbs and holds water. This helps the roots gather phosphate. Two farms, one in Pennsylvania[22] and one in England[24] raised the phosphate and protein content of milk 20 per cent by proper attention to the soil on which the forage for the cattle was grown.

Butterfat quality is also influenced by changes in the seasons. Price[20] noted that a fraction of butterfat important in bone healing and control of dental caries is present in butter produced when cows are eating fresh green pasture from land of high mineral content, but is absent from butter produced during dry seasons of the year.

Shifting attention from foods of animal origin to those of vegetable origin, the following table shows the range of phosphate content of various plant products.[5]

VARIATION IN PHOSPHATE ASH OF CROP

	In Per Cent
Winter wheat, grain	39.2 to 53.7
Maize, grain	37.6 to 53.7
Peas	26.2 to 44.4
Garden beans	27.1 to 46.6
Potatoes, tubers	8.4 to 27.1
Grapes, entire fruit	9.0 to 27.2
Asparagus, young stalks	13.8 to 21.9

In addition to the seasonal decrease in the phosphate content of food, the phosphate in water drops to practically nothing in the summer and fall.[13, 21] On the other hand, in the spring months water may contain enough phosphate to contribute significantly to the supply of that mineral to crops under irrigation.[15]

Algae and crustacea are dependent on the amount of phosphate in water.[9, 26] Since they are part of the food cycle of fish, fresh-water fish are subjected to conditions encouraging a phosphate and consequent phospholipid and protein deficiency during the fall season.

Calcium content is well maintained during the dry conditions that bring about phosphate deficiency in food,[3, 12] which further aggravates phosphate deficiency by interfering with absorption of the diminished amount of phosphate present.[19]

Animals are vulnerable to the seasonal changes in phosphate supply, for phosphate is not maintained in available body reservoirs although it is a major constituent of bone.[17]

DISCUSSION

Two other investigators have suggested that the phosphate availability from soil be given consideration as a factor influencing resistance and contributing to the epidemiology of poliomyelitis.

Albrecht[1] pointed out that the epidemic of poliomyelitis in 1946 was predominantly in the north central states, an area where the more calcareous soils give rise to lowered phosphate availability from the soil. Brumby[6] noticed that before bone meal was used to lessen phosphate deficiencies in cattle, cases of poliomyelitis were being reported at the same time local cattlemen were complaining about symptoms of phosphate deficiencies in cattle. Brumby further observed that the counties reporting the most cases of poliomyelitis were those in which phosphate deficiency in the soil was a glaring agricultural problem, and that the incidence of poliomyelitis steadily rose over the years in those counties where the topsoil and consequent water-holding capacity of the soil was being decreased by overcropping and erosion.

Neither of these scientists ventured a suggestion as to how lowering of phosphate availability from the soil would specifically influence susceptibility to poliomyelitis. In looking into the possibility that a seasonal lowering of food quality diminishes resistance to poliomyelitis, one must bear in mind that this factor may be companionate with principles of virus distribution and immunity found to be of significance in poliomyelitis and infectious disease in general. Certain facts that are now mysterious in the epidemiology of poliomyelitis may be of value in contributing material for definitive study. Important in this respect is the occurrence of epidemics in areas of more advanced civilization while backward countries continue to enjoy benign endemicity. It would be pertinent to determine whether the contrast in food quality related to the seasons is more crucial to people subjected to the changes of modern civilization than it is to those people of primitive countries where the nutritive balance has not been upset by the use of refined foods of many kinds and where the demand for nutritive factors is somewhat lower because of the lowered metabolism and decreased cellular mass resulting from a state of relative starvation.[25]

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REFERENCES

1. Albrecht, W. A.: Climate, soil and health. II. Managing health via the soil, Oral Surg., Oral Med. and Oral Pathol., 1:212, Feb. 1948.

2. Aycock, W. L.: The epidemiology of poliomyelitis. Virus and Rickettsial Diseases, p. 555, Harvard School of Public Health Symposium, Harvard Univ. Press, Cambridge, Mass., 1939.

3. Black, W. H., Tash, L. H., Jones, J. M., and Kleberg, R. J., Jr.: Effects of phosphorus supplements on cattle grazing on range deficient in this mineral, U. S. Dept. Agr. Tech. Bull. No. 856, March 12, 1943.

4. Browne, C. A.: Some relationships of soil to plant and animal nutrition, Soils and Men, p. 806, U. S. Dept. Agr. Yearbook, Washington, D. C., 1938.

5. Browne, C. A.: Some relationships of soil to plant and animal nutrition, Soils and Men, p. 781, U. S. Dept. Agr. Yearbook, Washington, D. C., 1938.

6. Brumby, W. M.: 811 Capital Ave., Houston 2, Texas. Personal communication.

7. California Agricultural Code: Chap. 25, California State Printing Office, Sacramento.

8. Caverly, C. S.: Infantile paralysis in Vermont, 1894-1922; a memorial to Charles S. Caverly, M.D., Vermont State Dept. Public Health, Burlington, Vermont, 1924.

9. Demolon, A., and Marquis, A.: Le Phosphore et La Vie, p. 15, Presses Universitaires de France, Paris, 1949.

10. Eckles, C. H., Combs, W. B., and Macy, H.: Milk and Milk Products, p. 55, McGraw-Hill, New York, 1943.

11. Hall, J. L., Mackintosh, D. L., and Vail, G. E.: Quality of beef. Part II. Effect of dietary phosphorus deficiency on quality of beef, Kansas Agr. Exp. Sta. Tech. Bull., 58:22, 1944.

12. Hart, G. H., Guilbert, H. R., and Goss, H.: Seasonal changes in the chemical composition of range forage and their relation to nutrition of animals, Calif. Agr. Exp. Sta. Bull. No. 543, 62 pp., Nov. 1932.

13. Hasler, A. D., and Einsele, W. G.: Fertilization for increasing productivity of natural inland water, Trans. 13th N. Am. Wildlife Conf., pp. 527-551, Wildlife Management Inst., Washington, D. C., 1948.

14. Howe, H. A.: Epidemiology of poliomyelitis in the light of modern research, Am. J. Med., 6:537-550, May 1949.

15. King, F. H.: Farmers of Forty Centuries, p. 186, Rodale Press, Emmaus, Pa. Originally published in England about 1907.

16. Infantile paralysis in Massachusetts in 1909, monthly bulletin, Massachusetts State Board of Health, Boston, Mass., June 1910.

17. Mitchell, H. H.: The mineral requirements of farm animals, J. Animal Sci., 6:365, Nov. 1947.

18. Morris, S., and Ray, S. C.: The effect of a phosphorus deficiency on the protein and mineral metabolism of sheep, Biochem. J., 33:1209-1216, Aug. 1939.

19. Effect of high calcium and phosphorus feeding upon bone formation in the rat, Nutrition Rev., 8:327, Nov. 1950.

20. Price, W. A.: Supplement to Nutrition and Physical Degeneration, Chap. 22. A new vitamin-like activator, p. 457, Am. Acad. Applied Nutrition, 1105 South La Brea Ave., Los Angeles, 1948.

21. Sauchelli, V.: Phosphates in Agriculture, p. 15, The Davison Chemical Corp., Baltimore 3, Md., 1951.

22. Snyder, C. H.: Milk is not always the same, The Land News, Series 12, No. 3, p. 21. Friends of the Land, 1368 N. High St., Columbus 1, Ohio, 1952.

23. Spencer, D. A.: Developments in sheep, Science in Farming, p. 213, U. S. Dept. Agr. Yearbook, Washington, D. C., 1943-1947.

24. Sykes, F.: Food, Farming and the Future, p. 104, Rodale Press, Emmaus, Pa., 1951.

25. Taylor, H. L., and Keys, A.: Adaptation to caloric restriction, Science, 112:215, Aug. 25, 1950.

26. Welch, P. S.: Limnology, pp. 212, 259, and 275, McGraw-Hill, New York, 1952.